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THE GYPSY MOTH EATS ITS WAY

FORESTRY SCIENCE PHOTO STORY

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INTO THE COMPUTER AGE

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THE GYPSY MOTH EATS ITS WAY

The gypsy moth lives up to its name. Since being inadvertently launched in Massachusetts in the 1860's by a naturalist, who had been conducting laboratory experiments to see whether the insect might have value in silk production, the insect pest has wandered like a gypsy, and turned some 10 states successively into hapless feeding grounds.

Finally it looks like the wizardy of computer technology, through a program designed by Forest Service scientists at the Forest Insect and Disease Laboratory in Hamden, Connecticut, may outflank the gypsy moth.

States that have been under attack by gypsy moth include Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Pennsylvania, and Vermont. Gypsy moths have also recently been spotted in Virginia, Maryland, and as far away as Florida. The long distance drive is attributed to the gypsy moth's modern mode of transportation: the moth larvae or eggs hitch rides aboard house trailers, driven from infested areas by drivers unaware of their non-paying passengers.

The gypsy moth's larva is a black hairy caterpillar with red and blue dots. In this stage of its life, the moth is most obnoxious, for it virtually eats up all tree foliage and green vegetation in its path. Only a few trees and plants, like grape vines, are not palatable to the voracious pest. Defoliation during 1970 amounted to 800,000 acres in Connecticut, New York, New Jersey, and Pennsylvania alone.

Evidence of Gypsy Moth Feeding: A stand of trees severely stripped of leaves early in the growing season.

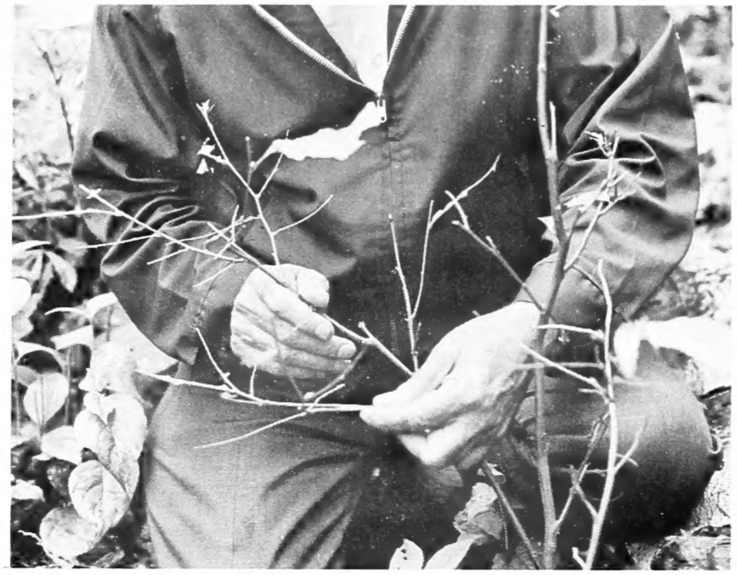
The most serious result of the moth's eating habits is the fact that hungry larvae, which emerge from their eggs in late April and early May, leave trees with only bare skeletons half way through their growing season. This stimulates trees to refoliate for a second time in one year, and puts intolerable stress on them. The season's second crop of leaves never reaches maturity, and is unable to produce enough sugars to feed the tree. With starch level and energy stores drained, trees starve. With vigor reduced, they are unable to fight off secondary attacks by various tree diseases. A single defoliation by the pest will sometimes kill spruce or hemlock outright. Hardwoods generally succumb following two or three seasons of defoliation.

■ Gypsy moths also lower the quality of the environment as they strip trees and vegetation of foliage. Besides robbing the landscape of shade and beauty, the pests lower many recreationists' enjoyment of the outdoors as they crawl over picnic tables and around barbecue pits. In addition, gypsy moth defoliation increases fire and erosion hazards, reduces land values, and destroys the homes and food supplies of other wild animals.

Numerous recreation areas are designated gypsy moth "hazards" each summer. This designation, meant to check the insect's spread, makes it mandatory that all mobile homes leaving such areas be inspected by a pest control agent first.

Gypsy moth populations range in size from the point of being tolerable up to being unbearable hordes of multi-hundreds of thousands. It is the aim of pest control programs to cut back the size of the populations to the point of tolerability, to the point where the environment can handle them

A severely defoliated sapling.

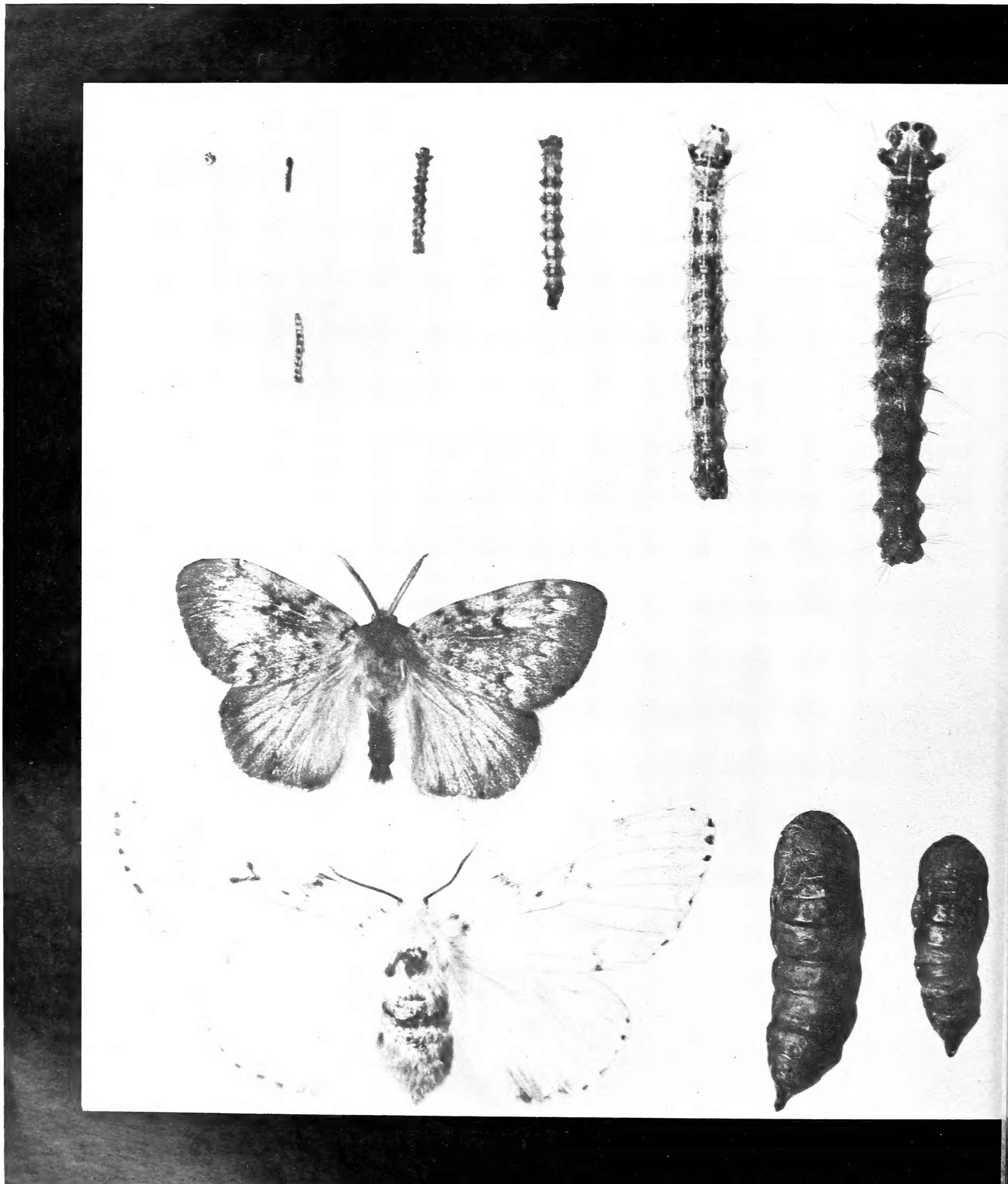


normally. Control programs are carried out by pest control agents of the states in which they occur.

■ Control programs once relied solely on DDT, which seemed an effective and easy solution, demanding little concern for the total environment. Today, programs use only non-noxious and degradable chemical sprays, like Sevin and Dylox. These are applied to forested lands by air in the spring about three weeks after the larvae have hatched. Sex lures have also been developed for trapping insects.

Many other programs for gypsy moth control are in the planning stage. A general lack of money and personnel is hindering their progress.

■ Future programs will probably be "integrated" efforts. This means that they will take all types of control measures and all aspects of the environment into consideration, in order to achieve a state of "dynamic equilibrium," where foresightful tree management measures have produced strong, vigorous trees, and where populations of gypsy moths are sized so that trees can withstand their attack.



A Gypsy Moth Gallery: The gypsy moth passes through various stages before the end of its year-long life. Eggs (like that in the upper left of the photograph) are produced in the fall and in this form the insect passes the winter months.

The insect emerges in late April or early May in the larval form (shown at various instar stages along the top). The insect is generally spread within local outbreak areas by wind during its first instar stage. Larvae are most damaging to green vegetation, because they feed omnivorously while increasing in size.

In July the insect turns into a pupa (lower right). The female pupa is larger than the male.

The white adult female moth which emerges (lower left) is, again, larger than the male. Although the female is unable to fly, she is capable of producing prolific quantities of eggs, which are fertilized by the more mobile adult males. About 70% of the eggs tend to be viable.

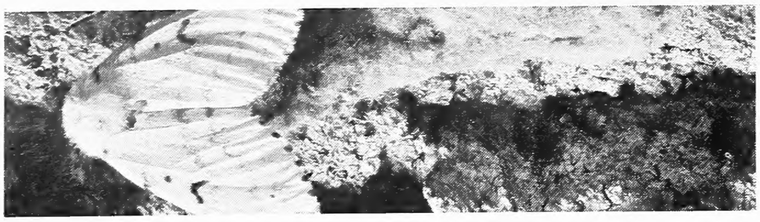
"Integrated control programs" will combine chemical with biological methods. Such methods include the use of refined forms of viruses and bacteria that are common pathogenic agents among gypsy moth populations.

Research is being conducted on the polyhedrosis virus of the gypsy moth with the intent of selecting the most potent source of virus for a particular target strain of gypsy moth. Biologists at the Forest Service's Hamden, Connecticut Laboratory have produced a purified form of virus and have found it six times more effective than its crude form. Scientists point out, however, that a great deal of further testing will be necessary before this virus is practical for control use.

The bacterial agent, Bacillus thuringiensis, is about to be marketed with FDA approval. The Bt, as it is commonly called, has a killing effect on a very limited range of life -- all of them insect pests. Forest Service researchers Dr. Frank Lewis and Normand Dubois are presently checking its effectiveness under field conditions.

Another means of achieving integrated control is through use of insect parasites and animal predators. About a dozen have already been established against gypsy moth in the United States. The parasites and predators are effective against endemic gypsy moth

Adult female laying eggs.



numbers in their various stages. Scientists working for the State of New Jersey plan to rear new and exotic species for release shortly.

There are quite a number of known predators of the gypsy moth, as well. They include grackles, starlings, red-winged blackbirds, bluejays, and white-footed deer mice.

■ Dr. Robert W. Campbell, Forest Service biologist, recently related fluctuations in the gypsy moth population to the size of the mouse population in an area. On investigation, he found that mice prey on moth pupae as the pupae lie dormant in the leaf litter at the base of the tree.

Hopeful of someday utilizing the mice predators more extensively in controlling gypsy moth populations, Dr. Campbell is beginning a study to track mice dispersal patterns and to account for their population stability or scarcity, accordingly.

To do this, Forest Service engineer Robert Neely designed and built a tiny battery-operated transistor radio signalling device that can be implanted just beneath the skin of mice. The radio transmitter is covered with either a plastic or a fibreglass capsule the size of a cold capsule. Because of its size, Neely assembled the transmitter under a microscope. The capsule has been surgically implanted with success into several mice under study at the Forest Service Laboratory.

Shortly, researchers plan to implant such devices into all newly-born mice within an assigned test area. The life-span of mice is approximately one year. When each mouse dies, the lowering of its body temperature will activate the radio signal. This signal can be picked up by receivers set along a grid within the designated boundaries of the study area. Using this signal, researchers will be able to locate the mice and investigate to determine other factors, such as birds of prey and various mammals which limit mouse populations. All this will provide them with information on how successful mice might be as full-scale gypsy moth predators.

Because such an elaborate electronic life-tracing system was never carried out before, there is a real possibility that the information from this test will be useful beyond the gypsy moth predation process. In fact, the final test results may provide invaluable information to other researchers, interested in ways to monitor the population dynamics of any number of animal species without having to keep them under constant observation.

■ One of the most perplexing quandries about the march of the gypsy moth has been the question of whether or not to spray to control it. Many states do not have capital available to put into costly, full-scale spray programs. Consequently, many lands, left unsprayed, turned into virtual gypsy moth nurseries within a year. But, just as many unsprayed areas quietly returned to normal moth numbers in the same amount of time. Hence the question: should we bother with control or not?

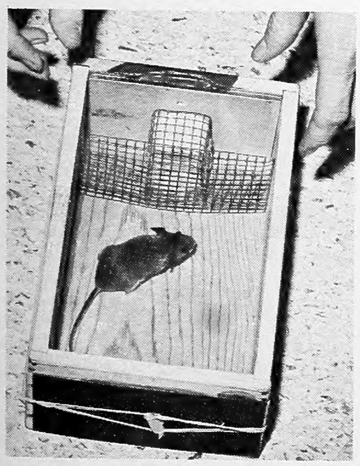
"What might be causing two seemingly identical populations to respond so differently?" scientists questioned. Perhaps the answer lay in environmental conditions, they theorized. So, Dr. Campbell and his associates began gathering data.

For 12 years, Campbell conducted field studies in Connecticut and Upstate New York. This data collection operation was a long and tedious one, expecially for Campbell's summer student aides, who were assigned the task of

Radio Transmitter Implant: A veterinarian, cooperating with the Forest Service, anesthetizes a white-footed deer mouse to prepare him for surgery.

The doctor cuts through layers of skin in order to insert the signalling instrument.

Surgery is termed successful after a period of time, when it is determined that the mouse's body has accepted the radio device and that the mouse has fully recuperated. Because all implants have been successful so far, scientists hope to begin field experiments shortly.

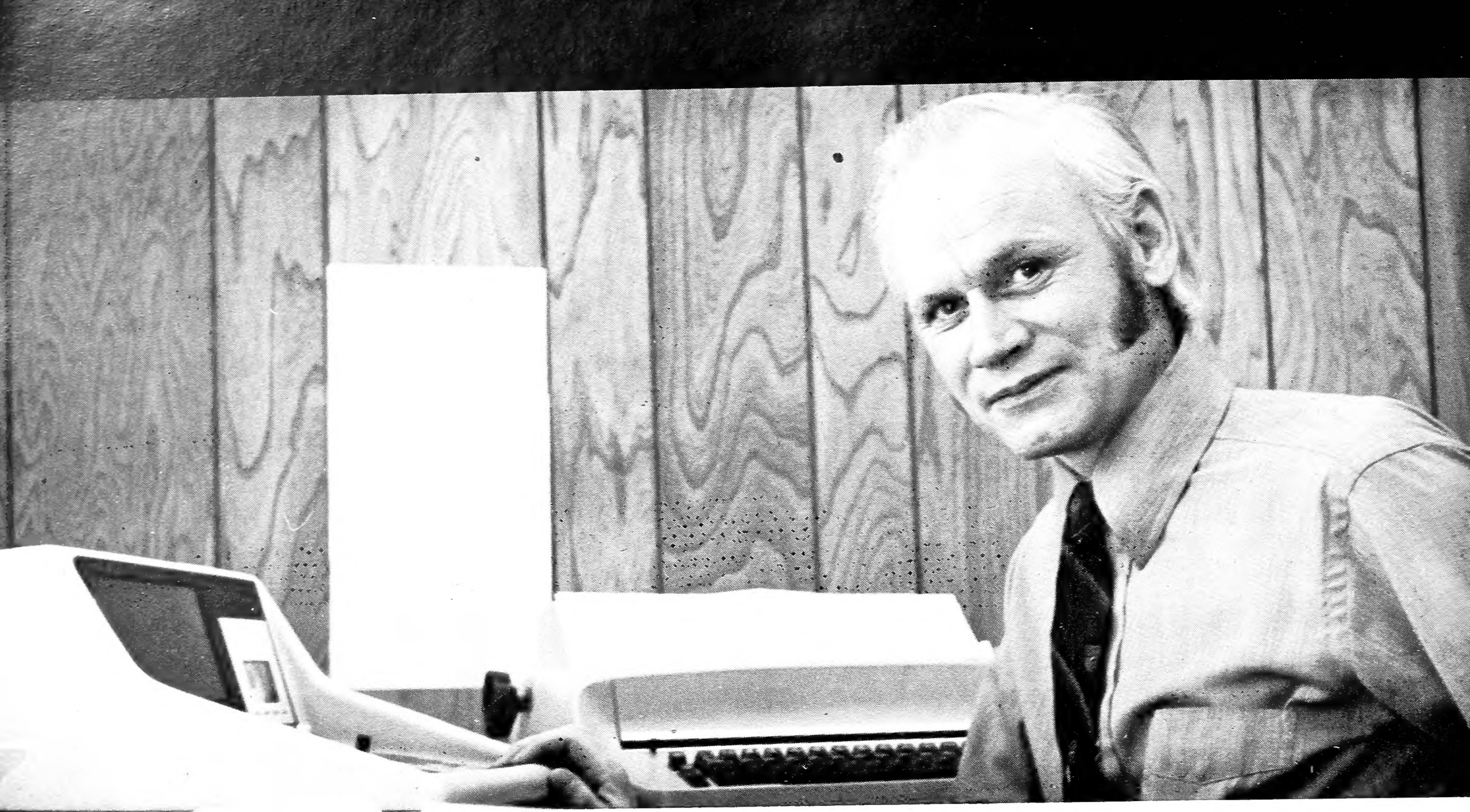


counting the end-of-summer crop of egg masses. In order to get an exact count, the boys had to climb trees, check out tree tops, examine all twigs and every trunk, and search under every leaf on the forest floor -- literally leaving no leaf unturned within the test zone.

Luckily for Campbell, he one day came upon a complete treasury of information on gypsy moths, and related climatic and tree conditions. The information had been gathered between 1911 and 1930 by a group of USDA researchers, stationed at the long-since defunct Melrose Highlands, Mass., Gypsy Moth Laboratory. After they had gathered the data, representing at least 100 man-years of work and 200,000 tree years, they realized that they had no means for analyzing it. So, the material was filed away until Dr. Campbell discovered it. Over the years, it had even withstood a fire. In 1964 the Forest Service's experimental laboratory on campus at Yale University was burned to the ground. The Melrose records were quite fortunately among the salvageable debris of that fire.

Combining this data with his own data and engaging a modern computer, Campbell has designed a "testable appraisal package." A computer program, it will help describe egg mass density and the amount of destruction it will do (in terms of overall defoliation, defoliation of the most valuable trees -- oak, grey and paper birch, willow, and aspen, tree condition, tree mortality, and tree growth loss), given a certain set of information on precipitation, temperature, and tree conditions, and the original size of the insect population. Social losses are at present not calculable.

Determining the exact number of egg masses for a year is important to Campbell's program of forecasting. It is the number of egg masses, coupled with a year's defoliation data, Campbell feels, that will serve as the best indi-



Forest Service researcher, Dr. Robert W. Campbell, feeds data into his computer.

cator of the size of next year's population and impact.

The computer makes the data evaluation task possible. It saves time and provides a shortcut around years of data. In fact, by simulating actual conditions with the computer, Campbell is able to forecast how next year's gypsy moth outlook shapes up. Ultimately, he also hopes to predict the number of trees which will die in a 5-year period, and the effect of defoliation on growth rates of trees. Then, putting the cost of treatment over the value of the land, he will be able to give an economic indication to states attempting to decide what to do about their gypsy moth problem.

Campbell has further plans to test out his projections. He expects to have a refined program to offer to state pest control officials by 1972. Then each state will be able to program its 1971 data to get a fairly accurate forecast of what kind of gypsy moth attack to expect during 1972.

Campbell's answers will offer suggestions to state pest control agents in considering what course to take -- whether or not they really need to spray to control pest outbreaks. By looking at the answers doled out by the computer, they will be able to see the consequences of both alternatives. Their decision for action will, then, have a sound grounding.

In addition to his research work, Dr. Campbell is also head of the Technical Committee of the Gypsy Moth Advisory Council, a group representing state, federal, university, and industrial interests. The group monitors outbreaks of the pest in states, coordinates detection and control operations, and recommends necessary research.

Results forecast the size of next year's gypsy moth population and predict the amount of defoliation.